Emerald Mining and Local Development: Three Case Studies in Brazil

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Abstract

For many centuries, emeralds have bejeweled the rich and famous all over the world. Emeralds have also made many millionaires over night, sometimes by chance. On the other hand, even though emerald mining has brought some economic benefits, the activity in many cases has caused several negative social and environmental impacts locally. Working conditions in small mines are very poor in general: bad ventilation, high temperatures, long working hours, lack of safety, informal working contracts and no health or life insurance. Environmental impacts can be significant, such as widespread deforestation, erosion of abandoned mines, soil and water pollution in the streams. The economic and social public benefits can be minimal. Even though taxes are not high, much of the mining activity is informal and the activities of high value-added take place outside the mining regions. Emerald mining regions attract many people, increasing the demand for public services (infrastructure, health, education, etc.), but local governments are unable to provide them because the activity often does not provide tax revenues. In the end, there is a growing mismatch between demand and supply of public services, leading to a series of social and environmental problems. However, emerald production has significant potential for local development. The purpose of this study is to understand the dynamics of emerald mining and its impact on local development through case studies in Brazil in three regions Campos Verdes/Santa Terezinha (Goias state), Nova Era/Itabira (Minas Gerais state) and Carnaiba/Campo Formoso (Bahia state).

1) Introduction

This article analyzes the impact of emerald production on local development through empirical research of three cases in Brazil. Emerald is one of the most valuable gemstones in the world. However, the places where the gems come from face several social and environmental impacts, as not much of the value of the gems stays locally, especially for the poorest and for investment in public goods.[1] There is a tremendous contrast between the local conditions where the emerald is produced and the jewels one sees on the hands of wealthy jewelry consumers or in the windows of jewelry stores.

The economic impact and potential related to emeralds are immense. However, little is understood about local social, economic and environmental impacts on the places where emeralds are produced. There is some knowledge on the technical part of emerald production (e.g. gemology, see Giuliani et al., 1998; Giuliani, 1997), but very few studies exist about the social, economic and environmental aspects of gem production, especially in academia. The purpose of this study is to understand the dynamics of emerald production in Brazil through case studies in the three most significant emerald producing regions in the country: Campos Verdes/Santa Terezinha (Goias state), Nova Era/Itabira (Minas Gerais state) and Carnaiba/Campo Formoso (Bahia state). This will help to generate lessons to upgrade small-scale gemstone mining activities in order to ameliorate their impact on local development.

Emerald production can bring a lot of benefits to local development, as production can generate millions (or even billions) of dollars. Many cases of gem production have shown an apparent increase in local economic activity, but the real increase seems much lower than the actual economic potential of the activity. Furthermore, those economic indicators have not been translated into indicators of local development. There are several reasons for this discrepancy between economic progress indicators and social development indicators. First, most of the activity is informal, so governments recoup little in tax revenues. Second, most of the taxes of the formal deals are paid where the gems are commercialized, not in the producing regions. Third, local governments receive very little from the taxes that are collected, as much of the tax revenue stays with higher level governments (state and federal). Finally, many of the emerald supply-chain activities with high value-added potential, like cutting and jewelry manufacturing, are done outside of the producing regions. Thus, when emerald is found somewhere, there is a huge increase in the demand for public services (infrastructure, health, etc.) as miners (*garimpeiros*[2]) and mining companies rush to the region, but local governments have little capacity to respond to those demands because there is not a proportional increase in revenues and institutional capacity. Also, since much of the activity is informal, miners have terrible working conditions, such as high temperature and humidity, long working hours, lack of safety and informal work contracts. The question of how emerald sectors can play a more important role in local

[1] Some specialists estimate that less than 5% of the retail price of a cut good emerald stays at local level, and much less to be invested in public goods (I estimate less than 0,1% for the local government). The 5% includes the private remuneration of miners, even though they may spend very little locally.
[2] *Garimpeiro* is the Brazilian word for small independent miner.

development is the motivation of this paper. Gem businesses, Non Governmental Organizations (NGOs) and governments each have important roles to play in addressing the poverty of many emerald-producing regions by promoting initiatives that help facilitate more effective local development.

The article is divided in three parts. The first part describes the three regions of study in the states of Bahia (BA), Minas Gerais (MG) and Goias (GO). In the second part, the text analyzes the social and economic dynamics of emerald production and how they impact local development in several aspects. In the third and final part, we conclude with some recommendations for improving the positive impacts of emerald production on local development.

2) Emeralds in Brazil

The explorers (called *bandeirantes*) in the seventeenth century searched several times in the interior of the country to try to find emeralds, but they never found any. Only in the 1960s, were emeralds found in the state of Bahia by chance. Since then, emeralds have been found in several places in Brazil in the states of Minas Gerais, Goias, Tocantins, Bahia and Ceara. The following chronology shows the discovery sites of the places where we can find emeralds in Brazil (**Table 1**). The history of appearance of emeralds in Brazil is also described graphically in the maps shown **in Figure 1** (Silva, 2004).

Table 1 – Places where emeralds are produced in Brazil

Year	***Place (State)***	***Who found***	***Comments***
1963	Salininha (BA)	-X-	First place where emeralds were found. Today the mines are inundated by Sobradinho Dam.
1964	Carnaíba (BA)	-X-	Do not produce anymore, Exhausted
1978	Itabira (MG)	-X-	-X-
1981	Sta Terezinha, now Campos Verdes (GO)	-X-	Still producing
1983	Socotó (BA)	-X-	Do not produce anymore, Exhausted
1988	Capoeriana, Minas Belmont e Piteiras (MG)	Rails workers	Still producing
1997	Monte Santo (TO)	A 12 years old boy	A boy found emeralds when he tried to drill a well in a banana plantation.
1995-1999	Garimpo do Toco (MG) Garimpo da Mina de Cantagalo (muncipalities of Nova Era/ São Domingo da Prata, MG)	-X-	Gems of excellent quality; Still producing
2000	Jazida da Fazenda das Piteiras (MG) between Itabira and Nova Era	Canadian company: Seahawk Minerals Ltd.. (sold to locals in 2003)	Found when drilling for exploration; Emeralds occur in an area of 20 Km^2 , out of a 10 km^2 area that belongs to the company

Source: Castañeda (2001).
Obs: The acronyms of the states. BA = Bahia, GO= Goias, TO = Tocantins, MG = Minas Gerais

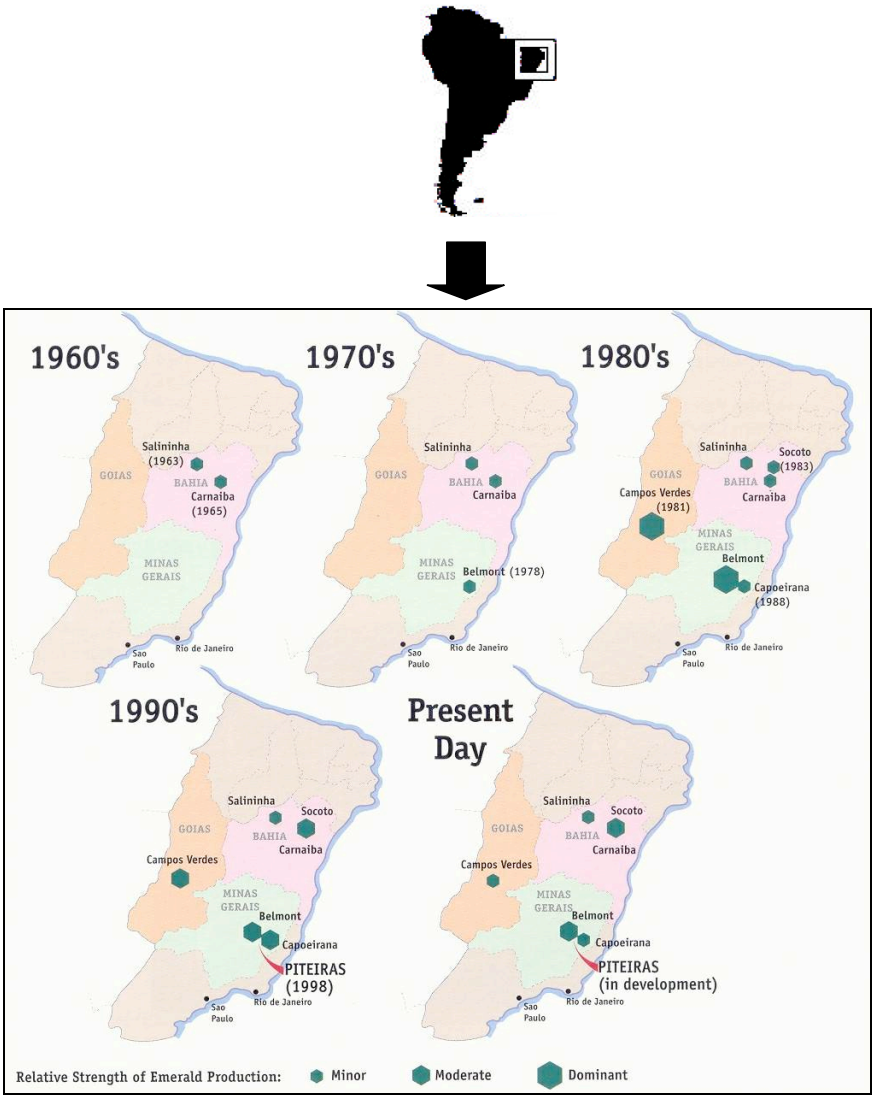

Figure 1 – Occurrence of Emeralds known in Brazil over time (the maps show the Northeastern part of the country)

Nowadays, emeralds are constantly produced in the states of Bahia, Goias and Minas Gerais, and recently in Tocantins (**Figure 2**). The production regions are:
• Bahia - Carnaíba, Socotó
• Goiás - Santa Terezinha, Campos Verdes
• Minas Gerais – Itabira, Nova Era (Capoeirana)

But emeralds have also been found in the following places:
• Bahia - Vitória da Conquista, Brumado
• Tocantins - Monte Santo (most recent discovery - May/1997)
• Minas Gerais - São Domingos do Prata, Antônio Dias, São José da Safira
• Ceara - Taua

According to a specialists,[3] the state of Bahia does not produce emeralds in economic scale anymore. Ceara had some emerald occurrences in the past, but no production has occured recently. The city with an economy depending on emeralds is Campos Verdes, and to a lesser extent Sta. Terezinha (GO) and Nova Era (MG).

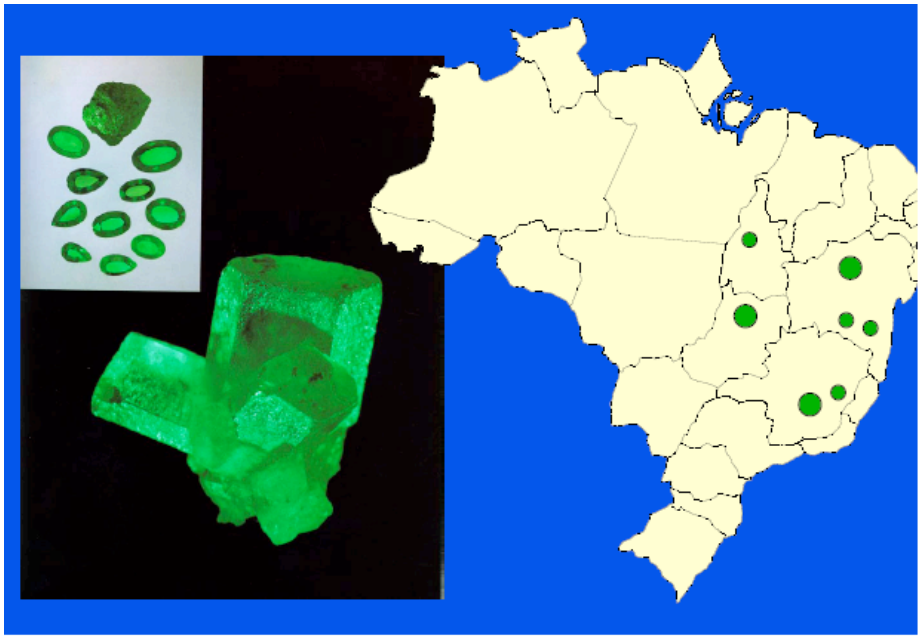

Figure 2 – Occurrence of Emeralds in Brazil. Source: Cigem, 2006

This research analyzes the three most important emerald producing regions in Brazil: Campos Verdes/Santa Terezinha (Goias state), Nova Era/Itabira (Minas Gerais state) and Carnaiba/Campo Formoso (Bahia state). These three regions produce more than 95% of the

[3] Dr. Jurgen Schnellrath of the Center of Mineral Research (CETEM).

Brazlian emeralds and those of best quality. The analyses of these cases help us to understand the dynamics of local development in an emerald-producing region.

2.1) Carnaiba and Socoto (Pindobaçu/Campo Formoso Region), Bahia (BA)

Bahia is the first place where emeralds were found in Brazil. In 1963, emeralds were discovered on a farm in the locality of Salininha, which is now under the waters of the lake that formed behind the dam of Sobradinho. Later on, in 1965, gems were found in Carnaiba around the town of Campo Formoso in the Jacobina Mountains. Until 1980, all the Brazilian emeralds would come from Carnaiba. They represented 25% of the gemstone exports of Brazil without counting diamonds (Santana, Moreira and Couto, 1995). Around this time, production in Carnaiba was declining, but a new vein was found in the nearby district of Socoto.

In the 1990s, Socoto represented two thirds of the emerald production of Bahia, while Carnaiba produced only one third. For example, between 1991 and 1993, the Jaconina Mountains in Bahia recorded 10.39 kilograms of emeralds (Socoto produced 6.33 kg and Carnaiba the rest) sold for US$21.4 million (Santana et al, 1995). Even though the region has not produced very high quality gems, a gem found in Carnaiba in 1974 holds the world record for the biggest emerald ever polished, weighing 86,136 carats with an assessed value of US$ 512,000 (Brazil Guiness, 2006).

The population cycle of emerald production in Bahia is similar to what has happened in other parts of Brazil where gems are found. As the first gems are found and the word gets spread, there is a rush of garimpeiros from all over the country to the area. In the case of Carnaiba, more than 6,000 garimpeiros were in the region in 1969 during the peak of the rush. As the production decreased, and word of other discoveries arrived, the number of miners diminished. In 2005, local miners estimated that less than 500 miners were still working in the region.

In Bahia, the emerald production is done only by small-scale miners, many of whom are garimpeiros. As the production in alluvial deposits diminish, miners who hold the mining rights of certain areas excavate deeper mines, which reach several hundred meters nowadays. The mining techniques in the region are very rudimentary even today. A few of the most established miners have some geological data to guide the mining activity.

The commercialization of the gems has diverse forms in the region. In Socoto, there is a local open-air market that works mostly in the morning, where one can buy rough emeralds directly from the miners or first-layer middleman. There is also a larger open-air market in Campo Formoso that functions until the evening. This market offers all kind of gems found in the region (amethysts, alexandrites, aquamarines, etc..), both rough stones and polished ones, and even some jewelry. Campo Formoso has several gem cutting and jewelry shops.

The sellers are miners or middlemen who got the gems directly from the miners or from other middlemen. The buyers of the gems are mostly middlemen from the region or from

other parts of Brazil, especially Minas Gerais. There are some foreigners as well, such as Indians and Israelis.

Even though the region has produced emeralds and other gems in abundance, the local population is very poor. There is a lack of all kinds of public services, such as sanitation, health and education. For example, Socoto has an open-air sewage system just next to the open-air market for high-valued emeralds.

2.2) Itabira Region, State of Minas Gerais (MG)

Itabira region in the State of Minas Gerais is probably the most productive emerald region in Brazil (Itabira region comprises of Itabira and Nova Era municipalities). It is the only place in the country where relatively large companies are involved in emerald production. There are a couple of well-developed large mining companies, as well as small production by garimpeiros in the nearby municipality of Nova Era.

Itabira is a well-known mining town. It has one of longest-running and largest iron ore production sites in Brazil (and in the world) dating back the 18th century. The multinational company CVRD (and its predecessors) started its activities in the region in the beginning of twentieth century. The economy of the city (and the region) is heavily dependent of iron ore. Much of the population of 105,000 inhabitants is linked somehow to iron production. Emerald mining is a small part of the economy, but an emerald mining firm called Belmont is possibly the second largest employer in Itabira (after CVRD).

The history of emeralds in Itabira is similar to the other emerald sites in Brazil. The gems were found by chance by a lucky person who had no experience in mining. In 1978, Mr. Mauro Ribeiro, a truck driver who inherited a 300 hectare plot of land, was digging a pool for his cows when he found some green stones, which he later knew were emeralds. He immediately registered the site with the mining agency (DNPM) and thus laid claim before the finding became public (two weeks later, when it became public, two other people tried to register the site). Mining started taking place with the leasing of the site to some garimpeiros. Later on, Mr. Ribeiro obtained the final mining license and ceased the lease to start his own company. He created the Belmont Company, which is believed to be the largest emerald producer in Brazil. Belmont is a family owned business now entering its third generation. It produces 60-80 kilograms of rough gems per month, 10 kg of which is good quality that can lead be sold for over US$1,000 a gram according to specialists.

There are few other relatively large emerald mining companies in the region. The Canadian Company, Seahawk came to the region in 1998 when it acquired the control of Piteiras mining. Seahawk started production in 2001, after a series of geological surveys. Seahawk invested large sums in planning the mining, but had financial problems in 2001 and 2002 and shut down briefly. It restarted operations with new owners from the nearby city of Teofilo Otoni. In 2003, it produced around 12 kg of emeralds per month. Another mine in the region is called Rocha, which is expected to produce up to 80 kg per month in the near future.

In the municipality of Nova Era, Capoeirana is a cluster of emerald production operated by small-scale garimpeiros. In the end of 1980s and beginning of 1990s, when emerald was first found in the region, garimpeiros rushed to the area. In the peak of production, 2,000 to 3,000 garimpeiros were living there. As emeralds became scarce, and miners had to go deeper to find the gems, garimpeiros left. Today, an estimate of 200 mine owners (and an average of 600 miners) outputs an irregular production of emeralds. Some mine owners bought their mines from former garimpeiros. Like at many other small production sites, there is a small town were most of the workers live, but there is no local market for the gems. Miners sell their gems informally in the mines, or in the nearby cities, or even in the regional gem center in the city Teofilo Otoni. Because of lack of environmental management in the debris and schist-washing process, the state environmental agency temporarily closed down all mines in Capoeirana in 2005.

The large mines (Belmont and Piteira/Seahawk) have a well-developed mine production. They use geological surveys for guiding the mining process. Belmont also has a sophisticated system that automatically sorts the gems by their quality and color. The system was designed by a German company and, according to Belmont's President, it is the only one of its kind in the world. Belmont also praises itself for its environmental management initiatives. The company plants trees during the closure process of mined terrain, recycles water used in the mining process, and even removes soil from the water and redeposits it in the mined earth to conserve nutrients and material while minimizing erosion. Belmont has been a model of careful environmental management and was even mentioned by the federal government (in a private conversation with the local branch of IBAMA, Brazilian Federal Environmental Agency).

Regarding taxes, Belmont's President said that his company is the highest tax payer in the emerald mining sector in Brazil. Nonetheless the amount is insignificant compared with the value of the gems. Belmont paid approximately R$70,000 (approximately US$32,000 as of May 2006) in CFEM taxes in 2004.

In Itabira, there is no significant gem cutting. Almost all gems leave the region as rough, to be cut in other parts of the country or abroad. Belmont has Canelhas, its own joint-venture company for emerald processing in Sao Paulo. Part of the production, in general low quality gems, is also sold as rough to Indian and Israeli traders. The nearby city of Teofilo Otoni, a national center for gem cutting, and Belo Horizonte, the state capital, receive most of the emeralds from the Itabira region that are not produced by Belmont. The gems are bought in the mine "mouth" by brokers from the cutting shops, or are sold directly in Belo Horizonte or Teofilo Otoni by the mine owners (or by middlemen). There is no open market for gem trading that operates regularly in the region. In Nova Era, there is a private small office for gem commercialization that buys from the local cooperative of garimpeiros.

There is very little interaction between the different scales of producers in Itabira Region. Apparently, the large producers do not know what is going on with their neighbor producers. They have their own independent chains and customers and do not need each other. The small producers (garimpeiros) have a relatively well-organized cooperative, but they have no contact with large producers, who could transfer some technical knowledge or

capital. The cooperative employs a technician who helps the garimpeiros to limit their tunnels under their license terrain.

2.3) Campos Verdes, State of Goias (GO)

In Goias, the main producers of emeralds are the municipalities of Campos Verdes, but they are also found in Itaberai, Porangatu, Pirenopolis and Mara Rosa. Almost all production is artisanal (DNPM, 2005). The state produced 44,567 kg of emeralds in 2003, generating R$ 2.6 million in commercialization (Table 8). However, production and values vary a lot over time due to changes in market prices, volume of production, the quality of emeralds produced and the volume of registered gems. Most of the gems mined outside Campos Verdes are of low quality. They are not used for jewelry, but for lower-value ornamental purposes, such as for decorating aquariums. Average prices vary a lot due to the quality of the gems and market prices. For example, the average price was R$ 837.53/kg in 1989 and R$ 29.63/kg in 2003 (both given in 2003 R$ equivalents such that 1US$=R$2.3).

Table 8 – Emeralds in Goias (price references at 31/Dec/2003 equivalent, 1US$=R$2.3)

Year	Production (Kg)	Commercialization (R$1,000)
1981	261	202
1984	49,454	9,252
1990	15,820	6,216
1995	81,754	15,823
2000	25,817	1,252
2001	38,101	444
2002	28,716	482
2003	44,567	2,684

Campos Verdes in the central state of Goias has some of the nicest gems and is the second largest producer of emeralds in Brazil, after the Itabira region. There are two relatively large companies, Enza and Itaubi (with estimates of 60kg/month of emeralds each), but the emerald production of these companies mostly carried out here by hired small-scale miners, many of them former garimpeiros. The municipality is located 320 km north of Brasilia and Goiania (the state capital).

In 1981, a farmer, who was a Japanese descendent, was building a road on his farm when he found the"green stones". Local people tell that "the Japanese" filled a truck with emeralds and disappeared after selling the land to a more experienced emerald miner from Bahia (Mr. Afranio). Later on, in 1984, the federal government transformed the farm into a "garimpeiro reserve" and thousands of people flocked to Campos Verdes. At the time, the town was still part of the municipality of Santa Terezinha de Goias (Campos Verde became an independent municipality in 1987). In the peak of the emerald boom, some estimates put more than 50,000 people in the region. The city's population grew without even a minimum of infrastructure. Now, the Brazilian Institute of Statistics states that the

population is around 3,000, but the municipality affirms it at more than 10,000. The reality is that many people left the city after the rush.

The main economic activity in Campos Verdes is emerald mining. In 2005, there were 452 areas marked for emerald exploitation, but only approximately 20 were actually producing regularly. Around 500 garimpeiros work in the region, some part time. It is estimated that 75% of the working population is involved with emerald mining somehow. Many mines have changed ownership. Some people from outside have bought some of the mines and introduced capital to upgrade production processes. Also, some mine owners have developed partnerships with investors from outside. Miners enter these partnerships with the local expertise and the mine rights, and investors enter with money. For example, one of the mines belongs to a man who emigrated from Rio de Janeiro in the 1980s and his partner is an investor from Sao Paulo who comes to Campos Verdes periodically to check the mine.

The federal and state environmental agencies have cracked down on some of the mines because of water pollution caused by the schist washing process and the uncontrolled disposal of debris from the mines. The agencies have developed some initiatives for cleaner production with the miners such as building some common pools for washing the schist. There is a branch of an environmental NGO, headquartered in the state capital, Goiania, that delivers some mining-related environmental education programs in the schools and also tries to approach the miners.

Most of the gems are taken to be cut in other regions of Brazil or abroad. The commercialization of the gems is done in an open market in the mornings. There is some gem cutting in Campos Verdes, and more in the next town of Santa Terezinha de Goias. Buyers come from other parts of Brazil and from India. The previous mayor even won a state prize for promoting emerald cutting and mining (SEBRAE, 2002). The municipality also developed other kinds of economic activities, such as agriculture (pineapple, rice, sugarcane, corn and manioc). Some of those activities were started by the investment of former garimpeiros, using the money they saved from emeralds.

The city of Campos Verdes depends completely on emeralds. As the mining activity is declining, after the rush in the 1980s, the city struggles to keep its population and develop some new economic activities while still promoting emerald mining. Some of local leaders and miners strongly believe that emerald mining is still viable, but capital is needed to improve production processes to reach much deeper deposits where they think large amounts of good quality emeralds exist.

3) Emeralds Production and Local Development

This part gives analyses of the potential impacts of emerald production on local development through the experiences of field research. First, the article links emerald production and human development index (HDI) in the three producing regions. There is no evidence that emerald production leads to better HDI. Second, it examines the economic

situation of people working in mining. Most of miners are under-employed and do not benefit much from emerald production. The third section analyzes the dynamics of emerald production and their impacts on miners and the local population living around the mines. Fourth, the article studies the impacts of emerald mining on local environments. Finally, it examines the situation of the miners working in emerald mines. Working conditions are especially poor in small mines, which are the majority.

3.1) Socio-Economic Conditions of the Three Regions

Even though each of the three regions produce high-value gems (emeralds), they have different socio-economic conditions. Emerald production is not the only determinant of socio-economic conditions but it is an important factor. The three regions are analyzed to facilitate understanding of possible and potential impacts of gem production, and patterns of societal conditions in which production takes place.

Out of the three cases, Minas/Itabira is the only one where gem production is not the main economic activity of the region. In the Itabira region, iron-ore mining and industrial activities are the strongest economic drivers. Even though Itabira (MG) region is the largest producer of emeralds in Brazil today, emerald mining is just a secondary economic activity. Emeralds are not even mentioned on the Itabira city home-page (www.itabira.mg.gov.br). In the case of Itabira, almost no gem processing takes place locally, and no local market exists to commercialize the gems. Basically, gems are sold to be cut outside the region.

Different from Itabira, the economies of the other two regions (Campos Verdes and Campo Formoso) revolve around gem production, especially emeralds. In Campos Verdes (GO), emerald production is the only relevant economic activity so far. In Campo Formoso (Bahia), emerald production is the main economic activity, but other gems are produced in addition to emeralds. In these two regions, there are active markets for gems and some gem cutting and jewelry production. Open-air markets exist in both regions, where one can buy gems directly from miners and middlemen. These attract gem buyers from different regions of the country and foreign nations. Also, both places do some gem cutting and jewelry production, but those activities seem to be small in scale compared to the emerald production, and they use only the low quality gems. Most of the good quality gems end up in other regions of the country or abroad.

Regarding development indicators, Itabitra (MG) region does much better than the other two regions (BA and GO), according to Table 1 and 2. Itabira and Nova Era rank among the 10% best municipalities in the state of Minas Gerais regarding the Human Development Index (HDI). On the other hand, the emerald producing municipalities in Goias and Bahia rank in the bottom half of their respective states in terms of HDI. Campos Verdes, for example, is among the lowest 10% of municipalities by HDI in Goias. Itabira and Nova Era (MG) have better HDI than Campos Verdes and Santa Terezinha (GO), even though Minas Gerais ranks below Goias in the average state HDI (Table 1).

One of the reasons that explains the low HDI of the municipalities dependent on gem production is that emerald leaves little benefits in the place where it is produced, especially public benefits. Very little tax is paid on gem production, as much of this activity takes place informally, and the formal activity is on the low end of the value chain(production of rough gems). Out of the little tax that is paid, just a small amount stays for local governments. There is no incentive for governments to control (formalize) or help emerald production since almost no economic value stays locally. Regarding private benefits, much of the value-added potential of emeralds goes to the hands of companies and individuals from outside the region of production, especially at the end of the supply chain (jewelry sellers and cutting of gems for luxury markets).

In sum, emerald production is not the only, or even the main, factor to explain the differences in development among the regions. Moreover, the information above shows that gem production does not necessarily lead to better social or economic performance. In the two cases where emerald production is the main activity, HDI and economic indicators are worse than in the case where emerald is not the most important economic activity.

Table 1 – Human Development Indexes for Brazilian States

UF	HDI-M 1991	HDI-M 2000	Change HDI 1991-2000	RANKING 1991	RANKING 2000	Change in the rank 1991-2000
Federal District	0,798	0,844	0,047	1	1	0
São Paulo	0,773	0,814	0,041	2	2	0
Rio Grande do Sul	0,757	0,809	0,052	3	3	0
Santa Catarina	0,740	0,806	0,066	5	4	1
Rio de Janeiro	0,750	0,802	0,052	4	5	-1
Paraná	0,719	0,786	0,067	6	6	0
Goiás	0,707	0,770	0,062	9	7	+2
Mato Grosso do Sul	0,712	0,769	0,057	7	8	-1
Mato Grosso	0,696	0,767	0,071	12	9	3
Espírito Santo	0,698	0,767	0,068	10	10	0
Minas Gerais	0,698	0,766	0,068	11	11	0
Amapá	0,691	0,751	0,061	13	12	1
Roraima	0,710	0,749	0,039	8	13	-5
Rondônia	0,655	0,729	0,074	16	14	2
Tocantins	0,635	0,721	0,086	17	15	2
Pará	0,663	0,720	0,057	15	16	-1
Amazonas	0,668	0,717	0,049	14	17	-3
Rio Grande do Norte	0,618	0,702	0,084	19	18	1
Ceará	0,597	0,699	0,102	23	19	4
Bahia	0,601	0,693	0,092	22	20	2
Acre	0,620	0,692	0,072	18	21	-3
Pernambuco	0,614	0,692	0,077	20	22	-2
Sergipe	0,607	0,687	0,080	21	23	-2
Paraíba	0,584	0,678	0,094	25	24	1
Piauí	0,587	0,673	0,086	24	25	-1
Maranhão	0,551	0,647	0,096	26	26	0
Alagoas	0,535	0,633	0,098	27	27	0

Table 2 – Development Indexes for the Municipalities where emerald production has an impact

Municipali-ty	State	Life expectancy at birth	Adult Literacy Rate	Rate of school attendance	Per capita income / Month (R$)	Human Development index (HDIM)	Ranking per state	National Ranking (Out of 5,500 municipalities)
Itabira	MG	72,798	0,903	0.876	264,521	0,798	45 of 853	599
Nova Era	MG	73,618	0,904	0,879	217,531	0,792	66 of 853	743
Santa Terezinha de Goiás	GO	67,630	0,809	0,884	158,745	0,721	171 of 256	2607
Campos Verdes	GO	63,332	0,792	0,940	143,043	0,694	215 of 256	3098
Campo Formoso	BA	60,856	0,668	0,809	91,236	0,613	245 of 415	4429
Pindobaçu	BA	59,361	0,684	0,771	78,294	0,595	319 of 415	4744

3.2) Socio-Economic Conditions of the Emerald Miners

There are no formal estimates for the number of small miners (garimpeiros) in Brazil, and thus no way to approximate the number of emerald miners in the nation. Officials of the mining agency of Goias estimate around 80,000 garimpeiros in the state. There are people working in the rest of the chain (cutting & polishing, stone treatment, sales, jewelry, services, etc.), and their number is also unknown. Populations of miners always fluctuate. When valuable gems are found, the local economy tends to grow, as there are flows of miners and fortune seekers establishing themselves.

As the economy grows, social problems also increase, such as lack of infrastructure and public services, prostitution, drugs, alcoholism and crime. In Monte Santo (TO), the first reaction of the mayor when emerald was found in 1997 was to increase the number of policemen from two to twenty. However, the population growth is not matched by proportional increase in municipal revenues generally, as gems do not generate much local taxes. Thus, the mining towns have a mismatch between the growth in population and the local economy on one side, and the lack of resources to provide adequate public services to the increasing population on the other side.

Almost all people working in the mines are men. Typically, they are around 25 -30 years old, single, and hold a low level of education (many are illiterate or completed less than four years of formal schooling). Women work in services like cooking or laundry. The population dynamics are seasonal and highly variable from year to year. In some places, people move out during the rainy season or when the mines have periods of low production. As new veins are found, new flows of people come and go. As the mines are becoming exhausted, part of the population tends to move to other mining regions, and the mining town becomes a “ghost” town.

There are several forms of organizations for emerald mining, and gem mining in Brazil. There are many independent garimpeiros who search for gems wherever they can in the fields. Sometimes, they are organized in cooperatives. These cooperatives include independent garimpeiros, who work for themselves and can hire others to help them out. Others work for mine owners. Some of the miner owners have legal rights over mines and others have only informal rights. Finally, there are formal large companies like the Belmont company in Minas Gerais. In the small formal and informal companies, the range of salaries is low (US$ 100-200 per month), or sometimes workers have no fixed salary and just receive part of what they find.

Informal work contracts are common, and health and life insurance is almost unheard of in small mines. The mine owners claim that formalization is difficult because there is a high turnover of workers due to mobility among garimpeiros. Many garimpeiros move to other regions when they hear of valuable minerals being found there.

Another difficulty of estimating the number of garimpeiros is that many of them work only part-time in mining. They are also small farmers or work in services or commerce in a nearby town. In their spare time, they go to “garimpo” in the field or buy some schist for washing with hope that they will find emeralds.

The necessary capital investments in emerald mines can be high, so it is not easy to become a mine owner. Besides the rights over the mine, it is necessary to make initial investments to hire workers, buy equipment and explore the mines. Registration and geological studies can be expensive, as can operational costs. Experienced miners say that one needs at least R$ 20,000 (US$ 10,000) upfront to start the activity. Running a mine also requires working capital for electricity, salaries, machinery, etc., which can run from R$5,000.00 to R$10,000.00 (US$2,500 to US$5,000) a month for a typical small mine. Miners have to keep spending money to maintain the mine until they find some precious vein, which can take several months or years. Many miners invest their own resources, sometimes earned from previous findings of emeralds or other precious stones. When those resources dry up, they close or sell the mine, or have to look for an investor to be a partner.

Returns can be good. A family in Campos Verdes who owns a mine has a revenue of R$ 50,000 (US$ 25,000) a month only from the "green stones" (low quality beryl gems that are used in construction and decoration) that their mines produce after two years of operation. However, they spend around R$5,000 a month in electricity alone. Furthermore, much of their earnings go unaccounted for because the accounting does not include what they call 'good gems' (pedra boa). The owner confesses that he can get 1 kg of good stones when they find a vein sometimes. The market value can reach R$ 12,300 (US$6,000) per gram depending on the quality.

Besides mining, other kinds of activities grow in the regions where emeralds are found, such as commerce, services and construction. Also, there are some improvements in the rest of the emerald chain, such as commercialization of rough gems and jewelry production. In Carnaiba (BA), the local market of beryl is intense, and buyers come from everywhere in Brazil and some foreign countries, particularly from India which is a major global stone cutting center. In Campos Verdes (GO), there is an incipient cutting and jewelry industry, which adds value to some of the rough gems.

3.3) Social and Economic Aspects of the Emerald Production in the Regions

Emeralds, like some other gems, are formed where there is a layer of contact between a mass of biotite schist and a mass of granite gneiss that became molten together millions of years ago. The concentration of emeralds in these gem pockets varies in each different vein, even though the process of natural production of emerald is the same. In some veins, the emerald is very concentrated in small pockets, like in the case of Bahia. This means that you can find emerald only proximate to the pocket. It can take a long time to find a pocket, but when one reaches it a large volume of gems are found. In other veins, the gems are less concentrated as they spread through a large area where the schist and granite gneiss touch each other, such as in the case of Goias and Minas Gerais. When miners feel they are in an area with good probability of finding an emerald, they remove a large volume of schist to wash carefully as a gem could be hidden somewhere in the middle of the schist.

In all the cases of emerald incidence in Brazil, the discovery happened when someone found the gems on the soil surface by chance, indicating that there was a vein around.

Firstly, the emeralds are collected by an open-pit mining process. Once the gem vein is exposed, miners dig to increase the diameter of the pit. Later on, this process becomes dangerous and there are risks of mine collapse (land slides), as well as negative environmental impacts (erosion, water contamination, deforestation, etc.). Nonetheless, miners have to make tunnels to go after the emeralds and when these tunnels are not reinforced and safely lit, they can be quite dangerous.

The miners follow the layer or layers between the schist and granite to try to find emeralds. They can conduct this process in two basic ways. The first is a technical way, as required by the law. Legally, miners have to make geological surveys to find out the position of the vein. where the vein yields a greater likelihood of finding emeralds, and the best way to make the tunnels based on the structure of the land. The second way is the "intuitive" way, the most common way among garimpeiros and small-scale mining companies. In this case, miners just dig tunnels following the layer between schist and granite intuitively. There are no studies to find the best way to build tunnels, and neither safety nor economic efficiency of the tunnels is assessed. Tunnels channel up and down in the hope that a gem pocket will be found. The tunnel structure is very rudimentary. Sometimes there are accidents because one tunnel collapses or reaches another one, which could be abandoned and full of water causing the unexpected inundation of the first tunnel. This type of flooding accident actually happened one week before our field work in Campos Verde, and miners where trapped several hours in the water. Luckily they were rescued.

There is a probability of finding gems when a special part of the layer schist/granite is reached. From this special layer, the schist mixture of beryl, soil, granite and other rocks has to be washed in order to spot the emeralds, which are generally encrusted in the rocks. The task of washing can be done by the mine owner, by mechanical equipment, by the miners or by the community. Some mines, especially those run by large mining companies, control the whole process. They take the schist mixture from the mines, wash the schist to try to find the emeralds and separate the gems by quality. This work can be done manually, or totally or partially by machines. In Belmont mine in Itabira, for example, machines even separate the rocks by color. The miner is paid a fixed rate by day of work in some cases and sometimes receives a portion of the found emeralds. Another possible arrangement is that the miner receives part of the schist mixture as payment (and then washes it himself with the help of his the family sometimes). If miners paid in schist are lucky enough, they can find some gems to pay their day of work.

Mines may sell or give the schist mixture to anyone who appears around the edges of the mine. In Campos Verdes, all mines sell schist mixture. Some mines do not wash the schist mixture at all, they just survive off selling the mixture. Other mines just sell part of the schist mixture, especially if they feel that the mixture is not of good quality. The value of a small cart of schist mixture varies according to the mine and quality of the mixture. A good mixture could reach R$50.00 (US$25.00) a cart in Campos Verdes. People from the community or from outside buy the mixture and wash it next to the mine or in designated washing areas (some of these places rent "schist washing machines" by the hour). The schist market is a kind of lottery. If one is lucky, he/she can become a millionaire in a few hours of washing schist mixture if he/she finds a good gem (there are stories like this in the region). In most cases people find only low quality gems that do not even have enough

value to pay for the schist mixture. Some people buy a cart, others buy a truck. Some are full-time miners or "schist washers", others are part-timers who sometimes come by to "try their luck" by buying schist mixture. There are cases of people who do not live in the region, but who come periodically to "try their luck" in the schist. In Campos Verdes, there were people from Bahia who come to buy and wash schist mixture once in a while, sell the gems and go back home afterwards. It is a kind of addiction, as one farmer (part-time schist-washer) mentioned in an interview: "I am just addicted to do it (wash schist mixture). I sell everything I earn from work to buy schist mixture. I sold my TV and microwave oven. Something is telling me that I will be a millionaire one of these days."

The relationship between the mine owners, the miners and the community depends on how gem pockets are formed in a given emerald-producing region. In Goias, where emeralds are not very concentrated, mines sell the schist mixture because they do not have the capacity to wash all schist. People are also willing to buy because there is some likelihood they can find good emeralds. Mines make consistent money selling schist. Sometimes this money is to finance the mining process. If mine owners feel that the mixture is especially good, they hold it for themselves. A similar process happens in Nova Era (MG), where garimpeiros buy schist from mine owners or exchange schist mixture for work in the mines.

In Bahia, the emeralds are more concentrated, so there is very little likelihood of having high-quality gems in the schist mixture, except where the pocket is located (miners call schist directly from the pocket "Veio do Sebo"). If miners find a "Veio do Sebo", they can make millions in few days. However, it can take years until one finds a *Veio do Sebo*, and miners can run out of money to finance the mining process before they get lucky. Mine owners do not sell schist in Bahia. They give away the mixture to the local people who live around the mines. Families wash the mixture together and generally find only a few low-quality gems per load, which just pay for their efforts to wash. Mine owners say this is "social work" for generating local jobs and helping local people. The population is poor, and there are not many job opportunities so those who can't find formal jobs need to work somewhere.

The assessment of the value of a rough emerald gemstone is one of the greatest barriers to increasing the value-added of emeralds in the hands of small miners. Even for specialists, estimating the value of a gem is very difficult before it is cut. Emerald gems always have impurities, which are difficult to assess fully before cutting. One apparently good gem could present a lot of impurities or break up when one tries to cut it, making it valueless. The large jewelry companies in Brazil (H. Stern, and Amsterdam Sauer) generally buy cut emeralds in order to avoid the risks associated with rough stones. Small miners, who usually live next to the mines, have little knowledge and power in the market of rough emeralds. Because of this lack of capacity, they get low prices for their gems in most cases.

3.4) Environmental Aspects of Emerald Mining

There are a series of environmental impacts that often result from emerald mining, such as soil erosion, deforestation and, soil and water pollution. Because emerald mining does not

incorprate any toxic materials or chemicals (like mercury in the gold mining), the environmental impacts are relatively simple to control.

Deforestation happens when mines are located in forested areas. Miners have to cut down or burn the forest to have access to the gems. Erosion is the most common problem in emerald mining. Mining starts in open pit mines, which become huge holes over time due to natural processes (rain). This can lead to uncontrolled erosion when mines are abandoned. In Campos Verdes (GO), a hole of 50 meters in diameter and 30 meters in depth was left in the place where some of the first gems were found. Abandoned mines also cause accidents, as people can fall in some of the holes.

Soil and water pollution are the most noticeable and widespread environmental problems in emerald mining. Debris from the mines and waste from the washed schist end up contaminating soil and stream water--contamination which can kill the vegetation and wildlife. This problem was common in all three sites of this research (Goias, Minas Gerais and Bahia), especially because of schist washing. The sites for schist washing are located next to streams because water is easily available there. The waste-water from the process runs into the streams and pollutes them.

Environmental and mining authorities are trying to control these problems in several formal ways, but with limited success. When someone wants to explore minerals, he should follow a process of legalization. Mining companies and miners should apply for registration for their fields (called 'lavra') from DNPM. DNPM tries to establish some rules to exploration, but enforcement is difficult because there are several sites and DNPM capacity is limited. There is no national policy for environmental licensing of gem mining. Each state in Brazil has its own legislation on licensing emerald mining.

In general, when some kind of precious mineral is found, there is a large migration into the region. The most recent case in Monte Santo in Tocantins state is typical. In 1997, a 15 year-old boy found a gem-quality emerald. DNPM had not even finished the study to estimate the mining potential and the quality of the emerald deposits, when within a few months, 3,500 garimpeiros arrived in town and the population tripled. Most of the garimpeiros came from other mining regions in the country in the states of Bahia, Maranhão, Goias and Minas Gerais. This happened only because 500 grams of emeralds were found. A cooperative of 3,424 independent mine workers (garimpeiros), called Coopergemas, was formed. Coopergemas started to press DNPM to increase the authorized area for exploitation from 50 ha to 200 ha, but before that, illegal exploration had been happening already. DNPM tried to control the situation by, for example, stipulating a maximum depth of 50 meters for the mines, but in Goias (Campos Verdes), there were mines of 300 meters deep already, formed by tunnels of 100 meters long with no control or geological studies.

One of the restrictions established by the federal government is the number of holes that can be opened on one mining claim. The idea is to avoid the excessive use of explosives that transform the mining areas into huge crater fields as in the case of the gold mining in Serra Pelada in Para state **(see photos 1 and 2).**

DNPM officials argue that they have limited capacity for controlling mines and need support from the state governments, especially the state environmental agencies. Environmental agencies have tried to enforce relevant laws to regulate miners. Agencies have certain enforcement capacity over larger mining companies, like Belmont in Itabira (MG), because there are only a few large players and these corporate entities have the technical capacity and resources to implement law requirements. Environmental agencies find it more difficult to enforce the laws over small-scale mines. These are much more numerous, more widespread, and informal. Most of them are not informed about environmental procedures and laws, nor do they tend to have the technical capacity and resources needed to comply with the law. However, environmental agencies have cracked down in mining regions recently. In all three sites of this research (Campos Verdes, Itabira and Socoto), miners reported the regular presence of officers from the environmental agency in the region. In Nova Era (MG), small mines were not operating during our field research (December, 2005) because the environmental agency required them to clean up the debris and solve the problem of pollution due to schist washing. In Monte Santo, the head of the state environmental agency (Naturantins) said that the cooperative of garimpeiros (Coopergemas) has to obey the environmental rules and undertake restoration and recovery projects in degraded areas.

Compared to small miners, large emerald mining companies, like Belmont, exhibit different behavior regarding environmental management in several aspects. First, large miners have a broader local impact as they use machines and the production is larger (so they move more soil), but they also have more technical capacity and financial collateral to control those impacts. Belmont, for example, has an automated system for sorting their gems, which generates less need to wash the schist, as well as a system for waste-water management. On the other hand, small miners have minimal local impact individually, but in general they are concentrated in large numbers in the same place, so the overall impact can be more pronounced than that of large companies. The washing of the schist is also done by a third party to a large extent, and thus is out of control of the miners. Second, even though enforcement of environmental regulations is generally weak (but improving) in Brazil, the environmental agencies tend to focus their enforcement efforts on the large companies because these operations have more capacity to respond effectively giving a larger impact and more visibility. Small miners are too many, too dispersed and have little capacity to respond to environmental regulations.

There are also apparent differences in environmental performance among the regions because of the kinds of mine production and capacities of the state environmental agencies. In Minas, because of the tradition of large mines of iron ore (CVRD), the state environmental agency has more experience in dealing with the mining sector. Officials had even closed down the garimpo in Nova Era/Itabira during the time of my visit (end of 2005). The enforcement capacity seems to be less in Goias and in Bahia, as those regions produce gems and gold at a small scale only.

Government agencies and NGOs have also implemented some initiatives to help mining regions solve their environmental problems. In Campos Verdes, the municipality and state governments created a series of common washing sites for schist buyers. Previously, schist washing was done next to rivers and streams without any control. Now, there is a washing

area with tanks that prevent run-off of wastewater and debris. In the same region, there is an environmental NGO that works on environmental education for small miners and others in the gem supply chain.

Photo 1: Gold garimpo in Serra Pelada in the 1980s, Para State Brazil.

Photo 2: Gold miner in Serra Pelada, Para State, Brazil (Sebastião Salgado, transporting bags of dirt in the Serra Pelada gold mine, Brazil, 1986)

3.5) Safety and Health Risks of Emerald Mining

Working conditions in small-scale mining of emeralds are terrible in general (similar to the conditions portrayed by the appearance of the gold miner in photo 2, above). Many miners work under extreme risks with little protection and no health or life insurance. In Campos Verdes (GO) garimpeiros are hired for working in mines at depths of up to 425 meters and temperatures of 60 degrees C (140 degrees F). They receive R$ 200 (US$ 100) per month. Garimpeiros work with their feet in the water sometimes and their clothes are always wet because of the high humidity and temperatures. The worst job is that of the 'quebradores' (rock pickers). They spend from eight up to 18 hours inside the mines fracturing rocks in a suffocating environment rife with air pollution. Sometimes they have neither drinking water nor food.

Some mine owners try to rotate the workers inside the mines to avoid accidents, the risk of which is also high. Water flows to the mines and has to be pumped out to avoid flooding or the collapse of the mine. If one tunnel reaches an abandoned mine full of undrained water, the water can rush in and drown miners inside the tunnel (or even cause them to be electrocuted by their power tools or electric lights). Just before my field-visit to Campos Verdes (in September, 2005), two miners were trapped inside a mine full of water that drained suddenly from another adjacent mine. Pumps from a third mine had to be used to

pump out the water during two days. Luckily, the two miners were rescued safely because they were kept alive in an air bubble at the end of a tunnel.

There is also the risk of mines collapsing because most of the mining structures are precarious. Some structures are made of wood and are not maintained regularly. Moreover, workers can fall when traveling up or down the mines. One example is the mine Santa Terezinha in Campos Verdes (GO). It has 1.2 km of tunnels and only one entrance. Workers move up and down in precarious elevators called 'jails' (gaiolas). The tunnels are not straight, so the jails bang on their walls. Many mines have no routine of changing the cables regularly (cables are changed only when they present clear signs that they are worn out).

Officials of the Ministry of Labor check a mine's conditions and enforce labor laws once in a while. In Campos Verdes (GO), around 2000-2005 the regional office of the Ministry of Labor (Delegacia Regional do Trabalho) closed down the largest six mines because of safety concerns. The mine owners say that it is too expensive to abide by the labor laws. "No one has ever died in my mines," claimed Cassio Braz, son of Delio Braz, a former Congress representative who owns the mines that were closed.

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Improvements in mining methods have been made in some places, especially when there are investments. In Socoto (BA) and Carnaiba (BA) mines are made of shafts up to 120 m. In the 1990s, the manual lifts were replaced by electric shifts in most of the emerald mines. In some garimpos, investors have visited, injected capital and cultivated partnerships with owners for the sake of increasing efficiency and scope of mineral exploitation. This has allowed garimpeiros to exploit deeper mines and increase the production in some places, as well as to improve safety and labor conditions. However, some problems continue, such as safety in the galleries and improper working conditions.

In the garimpos of Brazil, a growing problem is AIDS. There is no precise data, but the state health bureaus have reported 56 cases of AIDS contracted from garimpos. Most of these individuals had multiple sexual partners from the garimpo population; 20% used drugs and 20% were declared as homosexuals. There are several programs to try to prevent the spread of AIDS in garimpos including radio announcements and visits by health educators, but these initiatives are still not developed enough to meet the needs of the garimpos.

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4) Recommendations

Emeralds are some of the most valuable gems on the planet. For many centuries, they have bejeweled the rich and famous all over the world. Emeralds have also made many people millionaires overnight, sometimes by chance as in some of the cases reported in this study. On the other hand, even though emerald mining has brought some economic benefits, the activity has in many cases also caused several negative social and environmental impacts for most of the miners and the local populations. Working conditions in small mines are very poor in general: bad ventilation, high temperatures, long working hours, lack of safety,

informal working contracts and no health or life insurance. Environmental impacts can be significant: widespread deforestation, erosion of abandoned mines, and soil and water pollution in the streams. The economic and social public benefits are often minimal. Even though taxes are not high, much of the mining activity goes on informally and the activities of high value-added processing take place outside the mining regions. Emerald mining regions attract many garimpeiros, increasing the demand for public services (infrastructure, health, education, etc.), but local governments are unable to provide for them because the activity leaves little tax revenues. In the end, there is a growing mismatch between demand and supply of public services, leading to a series of social and environmental problems.

However, emerald related activities have a large potential for local development. The experiences in this study can shed light on potential conditions that would allow the production of emeralds to bring some social and economic benefits to local communities and miners, while simultaneously keeping its environmental impacts under control. In the remainder of this report, some recommendations are made to potentially improve the positive impacts of emerald production on local development.

I. Improve the conditions for partnership between small mines owners and investors.

Low capital requirements and rudimentary techniques can be sufficient to support emerald production when mines are shallow. However, as mines become deeper, working capital must be increased, as each additional meter of tunnel becomes more expensive to maintain due to increasing technical, safety, and environmental mitigation needs. Geological studies and more sophisticated techniques (both in equipment and organization) are necessary for safer and more cost-effective production. Therefore, capital and technical expertise are required for continuation of the mining activity. Many owners of small mines do not have the necessary capital or expertise to upgrade their production. For these businessmen, local and external investors can provide funding alternatives to improve mine production, especially at deeper mines. Some investors can bring both capital and expertise, or at least capital to import better techniques. Moreover, investors can facilitate creation of safer and better working conditions for miners by giving better equipment and formalizing working contracts. Investors are likely to be interested in improving conditions as they do not want incur the risks associated with mines closing because of failure to uphold labor laws.

One of the barriers to increasing the number of partnerships between investors and mine owners is Brazil's insecure environment for investments. Many investors cannot supervise production (they just come to visit the mines once in a while) or they do not fully understand the mining process. During my field visits, I came across cases of successful partnerships, which led to improvements in production, and cases in which investors were scammed by unscrupulous mine owners, and to a lesser extent, cases in which mine owners that lost their mines to investors. There is a need to make easy arrangements for partnerships and get both mine owners and investors more informed about contracts of partnership, and to do this in a way that fits the needs of mine owners, many of whom have a limited educational background.

II. Increase the public benefits (tax) for local governments in mining regions.

Mining regions are subject to population booms and resulting increases in demand for public services, but local governments are unable to increase service supply adequately because tax revenues do not increase proportionally to the demand. Even though economic activity increases, most of the gains are not officially accountable because mining activities and commercialization are mostly informal. Moreover, governments have little political and administrative accountability to miners because these workers do not pay taxes and generally do not plan to stay in the region for long. Increasing control over and amount of levied taxes could make local governments more effective at providing public services, as well as more accountable to local population.

The way to increase tax revenues is to formalize production and commercialization activities and increase the proportion of local governments' share in national gem taxes. Most of local governments do not have the institutional capacity to crack down on informality (and many do not want to do that because it would be politically disastrous). State or federal government (DNPM) would have to be the main responsible agencies for increasing formality. Finally, a larger part of the CFEM tax could come to municipal governments, once they bear most of the impacts of emerald production.

Many regions that do not produce gems receive taxes because gems are commercialized and processed there. A change in the tax laws would also be desirable to ensure fairess to local governments in regions where mining takes place. Gems should be taxed were they are produced, not were they are commercialized, or at least part of the taxes should stay where initial production takes place.

III. Formalize miners.

Many miners have terrible working conditions and none of the benefits of a formal work contract, such as social security, health and life insurance. Improving enforcement of labor laws in mining regions would certainly advance the public good, but would not solve the problem fully. Besides the bureaucracy and high costs of Brazilian labor laws, informality in mining is also widespread because the profession of "garimpeiro" is not fully recognized by law. Also, since miners have high turnover, mine owners do not want to go the effort to formalize them. A special kind of temporary contract could boost formalization of workers in emerald mining. Finally, labor unions could play an important role in formalization of work, if they were better organized and strengthened in the mining regions. Most of the miners' cooperatives currently do not aim to help in the formalization of workers.

IV. Incentives for voluntary amelioration of production activities.

Incentives from governments and national and international organizations could help to control some environmental aspects of emerald production. Many environmental impacts of gem production can be reduced by simple methods of environmental control, allied to stronger enforcement of environmental laws. The field research showed some cases where

inexpensive projects led to improvements in environmental quality, such as the installation of common pools for the community to wash schist in Campos Verdes.

The rehabilitation of abandoned mine sites could be boosted. The environmental NGOs in Campos Verdes could implement a program of environmental education and reforestation with very little in additional resources. Cooperatives or labor or trade unions could also lead the projects in some of the producing regions that do not have organized civil society or NGOs.

Trade unions and the CETEM (National Center of Mining Technology from the Ministry of Mines) could play an important role in designing solutions to the environmental problems of emerald production. Those solutions could be adapted to the local conditions, such as low maintenance and operational budgets and the need for easy installation options. CETEM has helped to design and promote solutions for mercury poisoning that occurs in gold mining, so it could also help in gem production.

V. Upgrade the chain of emeralds in mining regions.

The regions that produce emeralds have few activities in the high-end sectors of the jewelry supply chain, where most of the value added to emeralds is generated (through jewelry production). Out of the three case studies, only Campos Verdes (GO) presented some intensity of activities related to emeralds besides mining, such as stone cutting (lapidary arts) and jewelry production, but those were still insignificant relative to the quantity of emeralds produced in the municipality. Most of the gems leave their producing regions in rough form and informal status.

Local governments were not very successful in trying to increase emerald-related activities. Even though the municipalities in the three regions mentioned their intention to improve value added opportunities, they could not do much because of lack of political support, interest or technical capacity. Itabira had almost no post-mining economic activity, but had plans to create a school of gemology in a local technical school and universit. However, the municipality still needs to find funding for this project. Local authorities were trying unsuccessfully to convince the Belmont company to bring some of its cutting activities, which are done in Sao Paulo, to the city. Campos Verdes had a program aimed at upgrading the chain of emeralds, and even received a prize to recognize the program, but after a change in government it was discontinued. The present government had good intentions but little knowledge of how to implement the value adding program.

There is a need for professional training in stone cutting and in gemology for evaluating gems, as well as for capital needed to spur business growth and expansion. One idea is to incubate local jewelry initiatives. Another is to bring companies from outside the area to open manufacturing centers in the mining regions. Much needed help could potentially come from the state trade unions and SEBRAE (Center for Support of Small and Micro Firms, a quasi-public organization organized nationally). State and municipal governments could provide economic incentives and political support for bringing outside companies to mining regions and for the development of training programs.

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